

IMPROVED PV BUSINESS MODELS FOR ZERO ENERGY NEW HOMES: STIMULATING INNOVATION IN THE CALIFORNIA MARKETPLACE

Prepared For:

California Energy Commission
Public Interest Energy Research Program

Prepared By:
Navigant Consulting, Inc.

NAVIGANT
CONSULTING



Arnold Schwarzenegger
Governor

PIER FINAL PROJECT REPORT

January 2008
CEC-500-2007-090

CALIFORNIA ENERGY COMMISSION

Robert Shelton
Lisa Frantzis
Sannon Graham
Laurie Park
Bill Griggs
Contract #
Principal Authors
Navigant Consulting Inc
George Simons
Contract Manager

Golam Kibrya, Ph.D.
Technical Lead, Solar Energy
PIER Renewables

Ken Koyama
Supervisor, PIER Renewables

Nancy Jenkins, P.E.
Office Manager
Energy Efficiency Research Office

Martha Krebs
Deputy Director
ENERGY RESEARCH & DEVELOPMENT
DIVISION

Melissa Jones
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

Table of Contents

ABSTRACT	1
EXECUTIVE SUMMARY	2
1.0 PART I: Framework for Business Model Innovation	3
1.1 Introduction	3
1.2 Current Business Models Face Significant Barriers	5
1.2.1 Business-as-Usual	5
1.2.2 Market Barriers	6
1.3 Improved Business Models Offer an Alternative to Business-as-Usual.....	8
1.3.1 What is an Improved Business Model?.....	8
1.3.2 Seven Types of Improved PV Business Models for Zero Energy New Homes	9
1.3.3 How to Catalyze Improved Business Models	12
2.0 PART II: Development of Improved Business Models for Sustained Market Growth ...	14
2.1 Introduction	14
2.2 Work and Results to Date	14
2.2.1 Energy Commission’s Catalytic Activity	14
2.2.2 Industry’s Response	15
2.2.3 New Business Model to be Piloted	17
2.2.4 Is the Approach Working?	19
2.3 What Needs to Come Next.....	20
2.3.1 A Framework for Continuing Business Model Innovation.....	20
2.3.2 Monitor and Guide Pilots of Improved Business Models	21
2.3.3 Determine How to Proceed.....	22
3.0 Conclusions.....	24
APPENDICES	25

ABSTRACT

Seven new business models are proposed to accelerate the market adoption of solar photovoltaic (PV) and establish sustained growth in California. These are: PV as an appliance, no hassle PV, true value electric roof, PV enhanced affordable multi-family, PV consumer finance, PV enhanced mortgage, and utility PV in subdivisions. The primary barriers to PV market penetration and growth are identified. They include: high initial system cost, perception that the savings in electric bill is not significant, no added value for builders, additional hassle and risk for builders, limited value to homeowners, and limited value to utilities. The roles of the identified business models in addressing the market barriers are outlined and the possible ways to catalyze the business models are discussed.

Key words: Photovoltaic, business model, zero energy new homes, ZENH, home owners, builders, market barriers.

EXECUTIVE SUMMARY

Photovoltaic (PV) systems are one-tenth the cost they were in the early 1980's with the non-subsidized cost of PV declining at an average rate of 5 percent¹ a year due to technology improvements and economies of scale in production. California homeowners pay on the average \$9.33/Watt² to install a PV system. This is well above the \$3/Watt³ price, which is considered to be a breakthrough point for residential PV. Navigant Consulting Inc.'s research shows that improved business models can potentially reduce the initial installed price in new home construction to \$4-5/Watt by 2007. In addition, improved business models can address other persistent barriers to PV market growth (e.g., additional hassle and risk perceived by the home builder).

This paper shows how improved business models can complement current government policies, such as PV incentives and technology improvements, to accelerate the rate at which PV is fully commercialized and becomes competitive in the marketplace.

The California Energy Commission is in the process of PV business model innovation, and has successfully started developing improved PV business models for Zero Energy New Homes in California's rapidly growing residential home market. This paper describes what the Energy Commission has done to stimulate the development of improved business models, analyzes industry's response and then provides suggested next steps to keep the process of business model innovation moving forward.

¹ Navigant Consulting Inc. (NCI) estimate is based on interviews with PV manufacturers in 2004.

² In 2004 the average price for a PV system was \$9.33/watt, using the Energy Commission's data.

³ Frantzis, L. et al., Building -Integrated Photovoltaics: Analysis and US Market Potential, Prepared by Arthur D. Little for the US Department of Energy, Office of Building Technology, NREL/TP-472-7850, February 1995. Also quoted by the Solar Electric Power Association, 2004.

1.0 PART I: Framework for Business Model Innovation

1.1 Introduction

Photovoltaic (PV) is one tenth the cost it was in the early 1980s and in some areas of the U.S. that have a combination of good solar resources, favorable incentives and high electricity rates, PV economics are getting closer to cost competitiveness with retail electric power. The non-subsidized price of an installed PV system is expected to decline on average at about 5 percent per year⁴ as the technology continues to improve and manufacturing capacity expands allowing for economies of scale⁵. In addition, there has been a lack of adequate raw material silicon supply to meet the growing PV demand globally and concern that this condition might be persistent and result in high prices for solar PV, thus reducing piece gains in manufacturing and marketing⁶. While the price is decreasing, PV is still relatively expensive. The price homeowners pay in California for an installed PV system (pre-rebate) is on average \$9.33/Watt⁷. This is well above the \$3/W⁸ price considered to be a breakthrough point for residential PV.

Many of the policy initiatives aimed at achieving wide-spread PV adoption therefore structure near-term government support to fill this price gap and encourage market growth toward a self-sustaining level. It is anticipated that the subsidies can be phased out in later stages of development, when the market is self-sustaining. Currently, the most common policy mechanisms used to fill the price gap and accelerate PV market growth in the U.S. are investment tax credits, accelerated depreciation, buy-downs or rebates, and market development through educational campaigns and installer training programs.

There are, however, limitations to the current set of policy mechanisms being used. For example, the price gap is large, so price reduction incentives such as buy-downs or rebates are expensive to maintain over time. In California, the Energy Commission's

⁴ NCI estimates are based on interviews with PV manufacturers in 2004.

⁵ In the short-term (2005-6) the market price of solar PV might not reflect technology improvements and economies of scale in manufacturing because of worldwide constraints on module supply driven by high demand especially in countries with government incentives (e.g. Germany and Japan). However, in the medium to long term NCI believes that PV module supply will expand to cover current market shortages and the market price will fall to reflect the estimated 5 percent annual decline.

⁶ Based on interviews with poly-silicon suppliers, Navigant Consulting, Inc. does not believe that silicon supply will be a long term as companies are expanding manufacturing capacity to meet market needs.

⁷ In 2004 the average price for a PV system was \$9.33 per watt, using the Commission's data.

⁸ Frantzis, L. et al., Building -Integrated Photovoltaics: Analysis and US Market Potential, Prepared by Arthur D. Little for the US Department of Energy, Office of Building Technology, NREL/TP-472-7850, February 1995. Also quoted by the Solar Electric Power Association, 2004.

Emerging Renewables Program has provided over \$370 million in incentives for 112 MW of PV since its inception in 1998. In addition, stimulating market demand through these types of policies may not be enough to fully and efficiently commercialize PV. While these policies may create a large demand for PV and may result in increased levels of technology innovation, improved economies of scale and lower installed prices, this approach may not be as fast as policy-makers desire. In addition, price reductions alone might not address all of the market barriers that PV confronts.

This paper introduces a new approach that can be used to encourage the uptake of PV in the marketplace for use in existing infrastructure as well as new construction. The approach encourages the development of improved business models for PV which break through limitations associated with conventional business practices and more effectively address persistent market barriers. NCI's research shows that improved business models may be capable of reducing the initial installed price in new home construction to \$4-5/W_{pac}⁹ by 2007. Improved business models can address other persistent barriers (e.g., additional hassle and risk perceived by the home builder) and create additional value for key stakeholders. This paper describes how an improved-business-model approach can complement current PV incentives and technology improvements to accelerate the rate at which PV is fully commercialized and becomes competitive in the marketplace.

The Energy Commission selected new home construction in California for purposes of testing the concept that improved business models can reduce, and ultimately eliminate, the subsidy necessary for accelerating PV adoption. The adoption of PV into new home construction, in both single- and multi-family housing, confronts a set of barriers similar to the barriers found in other PV market segments. So, as a case study, the new home market provides a good opportunity to demonstrate the new business model approach.

The new home market in California represents a particularly interesting application for PV because new home growth is occurring:

- Rapidly and in large numbers. (Over 150,000 new homes are built in California every year.)¹⁰
- In areas with good solar resource.¹¹
- Where new electricity demand may lead to grid congestion, which PV could help relieve.¹²

⁹ See Appendix A for explanation.

¹⁰ "California Zero Energy New Homes" presented to California Energy Commission by Navigant Consulting, Inc., June 8, 2004. Main authors Ed Barbour, Adrienne Gvozdoch, Lisa Frantzis and Angela Milardo. Done in collaboration with the Florida Solar Energy Center.

¹¹ Ibid.

¹² Ibid.

In response to the rapid growth in new home construction, the Energy Commission and other agencies are stimulating the development of more energy efficient new homes in California. They are attempting to make the concept of a Zero Energy New Home (ZENH), a home which combines energy efficiency and on-site generation (e.g. PV), within the financial reach of many new homeowners.

While solar PV could play an important role in helping California manage its energy resources in a period of tremendously high growth in the new home market, current PV business models do not sufficiently serve the market. In particular, there is a great opportunity to combine improved PV business models with the effort to develop ZENHs. As the ZENHs will reduce the energy consumption of a home, PV can cost effectively provide a larger percentage of the overall energy demand and reduce peak power requirements from the electric grid.

Part I of this report describes the current business models for PV systems in new home construction and the market barriers they face. The approach for improving business models is then introduced along with ideas on how to catalyze their development. Part II explains the recent Energy Commission activities to catalyze improved business models in California in the new home market. The report concludes by outlining next steps so that improved business models are fully developed in the marketplace and, ultimately, the need for subsidies is eliminated in the sector.

1.2 Current Business Models Face Significant Barriers

A business model can be described as the process by which value is created, sold and delivered to a customer; this value can be in the form of a product, a service or both. While current PV business models deliver value to customers, these models operate with considerable barriers which inhibit their full market potential. This section describes a common PV business model found in the new home market and the associated market barriers.

1.2.1 Business-as-Usual

There is a wide range of identifiable PV business models for the new home market in the U.S. Figure 1 depicts a simplified example of a business model common in the Californian new home market. A builder purchases a PV system from a retailer and then hires an installer to put in the PV system. The local utility reviews the system interconnection and addresses any issues related to net metering. Local government building officials review the installation for compliance with building codes while state and federal government agencies offer incentives to reduce the overall system cost. A financial institution may provide the homeowner with a loan for the PV system, which could be included as part of the home mortgage. The homeowner purchases the new home with the PV system.

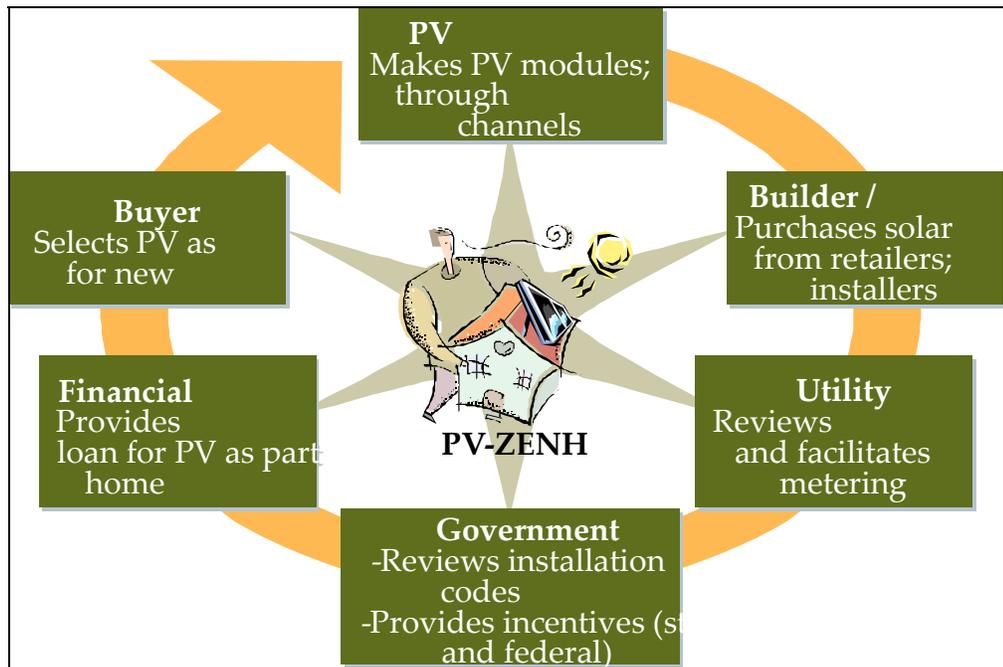


Figure 1 An Illustration of a Common Business Model Used to Sell PV in the New Home Market

Note: The arrow is not indicative of the order of activity

1.2.2 Market Barriers

PV adoption has been slow to evolve in the new home market. One reason is that the main stakeholders, including the builders, homeowners and utilities, do not perceive that they would derive enough value from PV installed on new homes. After working with the Energy Commission staff and speaking with major PV stakeholders, four categories of market barriers were identified as the most challenging and persistent to PV adoption in the new home market.

Barriers include:

- **Unfavorable Economics** (initial system cost and minimal reduction in monthly electric bills). High initial system cost was identified as by far the most significant barrier hindering PV adoption. Stakeholders agreed that reducing the initial system cost would have a profound impact on the amount of PV in the marketplace. In addition to high initial PV system cost, the reductions in monthly electric costs are perceived to be minimal. As a result, customers do not realize the return on investment that they need in order to justify such a large capital expenditure.
- **Lack of Value for Homeowner** (perceived hassle and risk, no additional value, and aesthetics). It is not the economics alone which prevent customers from purchasing PV systems. The hassle and risk related to the purchase of a PV system are also factors that dampen sales. For example, homeowners often purchase a system which lacks a single, overall warranty and are left to deal with a variety of equipment manufacturers if problems

are encountered. The homeowner can have difficulty finding certified repair people. In addition to the increased hassle and risk, it is hard for homeowners to identify other value they derive from a system. While some homeowners may be motivated to purchase a PV system due to environmental concerns, for others “doing something good for the environment” may not create enough value to motivate a purchase. (i.e. create value like the “status” that comes from driving a Prius©). Other potential sources of value, like Renewable Energy Credits (REC), are perceived to be difficult for the homeowner to monetize.

There is also often an aesthetic issue with PV; some homeowners and builders do not like the way PV systems look and are not willing to compromise aesthetics for minimally perceived energy cost saving. Aesthetics for commercial building installations are often not an issue, as PV is installed on flat roof buildings and are not often visible from the street. Residential PV systems, by comparison, are often installed on pitched roof buildings and may not have uniform color or may not be installed and cover the full side of the roof. Lower-cost PV shingles are being developed, however, that may help alleviate some of these concerns.

- **Lack of Added Value for Builder** (perceived hassle and risk, no additional value). In the new home construction market, the builder is also central in the PV purchase decision. The builder, like the homeowner, perceives hassle and risk related to PV system purchase, installation and long-term liability. For the builder adding PV onto a new home apparently produces little additional value, and therefore builders found little reason to “push” PV to the homeowner. In addition, a PV system could result in construction delays adding costs and increasing the time it takes a builder to finish a house and get it to market. For example, the PV permitting process can be long and PV systems might not be available immediately in the marketplace. The building community expressed an opinion that an entitlement process from the government that would allow builders faster and easier permitting in exchange for installing PV on new homes would be valuable, and would significantly increase how they valued PV. In addition, builders are also concerned by the associated long-term liability of the system. Currently there is a discrepancy in the marketplace between the 10-year warranty offered on the house by builders and the 5-year PV system warranty required by California incentive programs.
- **Lack of Value to Utility.** Utilities often perceive little value in residential PV and do not facilitate its adoption. Many utility companies do not believe that PV installations can ease congestion, as PV output is intermittent due to the variable solar resource. While in some cases PV output may match a utility’s peak demand, in others it may not, as is the case in San Diego. Even though PV systems are reliable, the reliability requirements of many utility transmission and distribution systems are not perceived to be adequately met with PV output.

1.3 Improved Business Models Offer an Alternative to Business-as-Usual

Improved business models can address the market barriers discussed in the previous section, accelerate adoption of PV and, ultimately, help reduce and then remove the need for subsidies in the sector. The improved-business-model approach presented below was developed by studying other industries that have undergone successful business model change and transformation.

This section first describes the concept of an improved business model (what it is and how it is developed). It then presents examples of improved PV business models for the new home market. Finally, this section addresses how improved business model development can be catalyzed in the marketplace, with particular attention paid to how a government agency can act as the primary catalyst.

1.3.1 What is an Improved Business Model?

A business model describes how a product or service is created, sold and delivered to the customer. Improved business models address market barriers present with existing business approaches and improve overall value delivery. Figure 2 shows three levers (i.e. strategies) which can be used alone or in combination to improve existing business as usual (BAU) business models by changing the value proposition, supply chain or target customers.



Figure 2 Three Levers for Improving Business Models

Source: *Making Innovation Work*, Davila, Epstein, Shelton; Wharton Press 2005

Using these three levers to improve BAU business models can result in significant change in the way business is done or even conceptualized. Examples of successful business model change abound in the business world. Three cases from other industries are described in Table 1.

Table 1 Examples of Business Model Change

<p style="text-align: center;">Change in Value Proposition (change what is sold)</p> <p>IBM expanded its value proposition from selling only computer hardware to bundling it with consulting services through the acquisition of PricewaterhouseCoopers' consulting practice in late 2002.</p>
<p style="text-align: center;">Change in Supply Chain (change how it is sold)</p> <p>Dell radically changed how people could buy computers. Instead of having to go to a store and interact with a salesperson and multiple brands, Dell sold directly to the consumer using a virtual web-based store. Using the web-based interface Dell also allowed customers to tailor their computers to fit their needs.</p>
<p style="text-align: center;">Change in Target Customer (change who it is sold to)</p> <p>Nutrition bars were initially marketed as a snack food to the general public. Later they were targeted to specific markets. While the basic product remained the same, the target customers changed dramatically. For example; Luna Bars® for women, PowerBars® and Clif Bars® for extreme athletes, Balance Bars® for individuals seeking high protein, low carbohydrates, etc.</p>

When thinking about improved business models there are key points to keep in mind. First, improved business models complement technology innovation. While they do not supersede technological advancements, they can act in concert with them. Second, to be successful, improved business models must address market barriers. Therefore, understanding which market barriers are the most critical to overcome is essential. Third, improved business models may require new partnerships (e.g., a financial institution working with a local government and home builders), which can take time and energy to develop. The changes in the marketplace that result from improved business models may not be immediate; however, a perceivable change can often be seen in the short-term, especially with respect to addressing the most challenging market barriers.

1.3.2 Seven Types of Improved PV Business Models for Zero Energy New Homes

Using the concepts presented above regarding improved business models, NCI worked with the Energy Commission and PV stakeholders to develop improved PV business models for new home construction and ZENHs. The result of this work is seven improved core business models which are described below. These improved business models emphasize what is possible on a large scale in new home construction, especially if new partnerships are formed. They contain new business elements as well as concepts that have been thought of and used in the past. The improved business models that were developed are not exhaustive, however. Additional improved business models are always possible.

The importance of improved business models is that they are a departure from business-as-usual; the way business is predominately done today. Some of the ideas,

for example, including the cost of the PV system in a mortgage, have been tried and therefore are not “new” per se. However, these ideas are not yet a part of the mainstream market and have not been successfully adopted in a manner that allows for large-scale roll-out. It is possible that ideas tried in the past still hold value, but need to be developed and implemented in different ways. These improved business models do not necessarily represent radical innovation, but rather are put forth as examples of how improvements to business-as-usual can reduce serious barriers in the marketplace.

The seven improved business models developed by NCI are highly stylized; each one is a tangible, distinguishable and powerful business concept. Together they act as basic building blocks. Each of the seven improved business models developed represents a basic market approach that can be 1) a stand-alone market development strategy, 2) combined as a basic unit with another to create more value, or 3) used as a backbone concept to create a greater family of business model variations.

A brief description of the seven improved core business models is included below. In addition, a full one-page description including the value created by each improved core business model can be found in Appendix B. The descriptions below together with Figure 3 and the material in Appendix B describe how the new business models address the high initial cost of PV and other market barriers. In addition, Appendix A contains a description of how NCI estimated the impact the improved business models have on initial system cost.

The seven core improved business models developed by CEC, NCI and key stakeholders, include;

- **PV as an Appliance:** The PV as an Appliance business model centers on the notion that a PV system can be sold to a homeowner or builder and incorporated into a home just like an appliance. The PV system is a standard, pre-engineered product that comes with full performance guarantees and warranties, similar to a common appliance. The product is sold through high volume sales channels and could include options for financing and maintenance contracts.
- **“No Hassle” PV:** The “No Hassle PV” business model centers around the idea of a single entity (a company) that bundles the PV system design, purchase, permitting, rebate application, installation, maintenance and possibly financing into one single, simple transaction for the customer (homeowner or builder).
- **True Value Electric Roof:** With the True-Value Electric Roof business model the PV system becomes the roof, replacing a portion of the roofing material used in new home construction. This building integrated product could be used in both single- and multi-family residences. Time-of-use electricity metering provides the homeowner with improved economic incentives and helps to decrease monthly electric costs.
- **PV Enhanced Affordable Multi-Family:** The PV Enhanced Affordable Multi-Family business model utilizes a large PV system that is included as part of new construction in order to reduce the on-going electric bills. The affordable

housing developer may be eligible to claim additional tax credits when PV is installed.¹³

- **PV Consumer Finance:** In the PV Consumer Finance business model, the initial PV system cost is financed using standard consumer finance channels. The financing could be provided to the consumer by a PV manufacturer, other market participant (e.g., distributor), a new 3rd party, or an independent financing entity.
- **PV Enhanced Mortgage:** Using the PV Enhanced Mortgage business model, lenders incorporate the PV system cost into the home mortgage and provide “enhancements” to the mortgage terms because the new home has a PV system installed that can reduce monthly electric bills. This model assumes that financial institutions will consistently offer the PV component as part of mortgage services, thus creating a high-volume revenue stream (good for the bank) and a streamlined, inexpensive process (good for the customer).
- **Utility PV in Subdivision:** With the Utility PV in Subdivision business model, a utility develops and owns PV systems in new subdivisions either on a house-per-house basis or as a small centralized system located within or near the subdivision.

These seven improved business models were developed to address the most persistent market barriers identified earlier. Figure 3 depicts how well each improved business model addresses the key barriers described earlier in Section 1.3.2. Figure 3 illustrates that many of the improved business models significantly address the barriers of “high initial cost” and “limited value to the homeowner”. To a lesser degree, the barrier of “reduction in monthly electricity cost” is addressed by the business models. The barriers of “hassle and risk for builder” and “value to utility” were addressed to a very small extent, as only two business models addressed them at all.

In Figure 3 it is notable that while the business models address most of the barriers, none of the business models really addresses the barrier of “No added value to builder”. As explained above in Section 1.3.2, entitlements (i.e. fast tracking permits for including PV in new home construction) were mentioned by the building community as one way to increase the value of PV to them. When NCI evaluated the seven core business models, entitlements were treated as an option for each business model; the business models were designed to function without the entitlements, but entitlements could be added as an additional feature. Since entitlements would be available to builders based on a local policy decision, NCI decided to treat entitlements as an option that could be added or taken out of any business model. For each business model it is possible to imagine that the barrier of “No value to builder” is addressed, at least partially, by the addition of builder entitlements.

¹³ Affordable housing developers are granted tax credits by government which can be sold to finance construction. Tax credit allocation is a competitive process and based on evaluation of the characteristics of the proposed facility.

Another point to note is that none of the improved business models by themselves addresses all, or even a majority, of the market barriers. Similarly, none of the improved business models alone provides incentives required by all key stakeholders to motivate their participation. Therefore, to address the majority of the key barriers and motivate key stakeholders in a single business model, some of the elements from multiple improved business models will need to be combined into one.

Business Model	Value					
	Cost Barriers		Other Barriers			
	Initial system cost is high	Reduction in monthly electricity costs is not noticeable	No added value for builder	Additional hassle and risk for builder	Value to homeowner is limited.	Value to utility is limited (unwilling to cooperate)
→ PV As an Appliance	●	◐	○	◐	●	○
No Hassle PV	○	◐	○	◐	●	◐
True-Value Electric Roof	◐	●	○	○	●	○
PV Enhanced Multi-family	○	○	○	○	●	○
→ PV Consumer Finance	●	○	○	○	○	○
→ PV Enhanced Mortgage	●	○	○	○	◐	○
→ Utility in PV Subdivision	●	○	○	○	●	●

● Significant impact (4 - 5) ◐ Moderate impact (3) ○ Low impact (0 - 2)

Figure 3 An Analysis of How The Seven Improved Business Models Address Market Barriers

Finally, it needs to be noted that the seven core business models do not cover all the business model options possible in the marketplace. For example, utilities could provide incentives to customers or government could make volume purchase commitments with manufacturers. These, and other, business models may be viable options for stakeholders to consider, and may warrant investigation and consideration in the future.

1.3.3 How to Catalyze Improved Business Models

There are countless examples of industries that have been launched or significantly enhanced by changes made to a commonly accepted business model (e.g., Ford’s improved business model for producing the Model T revolutionized the auto industry). While industry must be intimately involved in this process, government can play an important role in creating programs or policies to stimulate the creation and development of improved business models within a targeted industry.

For government, catalyzing and exploring improved business models with industry can be a powerful addition to the current set of policies and programs available. In fact, an improved business model approach can complement and leverage existing programs and policies such as investment in technology improvements and financial

incentives such as buy-downs, investment tax credits, accelerated depreciation, rebates, and market development through educational campaigns and installer training programs.

Catalyzing improved business models will require that stakeholders:

- Develop business models that clearly address the most crucial market barriers
- Integrate new ideas with existing practices
- Form new partnerships
- Take on new perspectives and work in new ways
- Develop and test new models
- Implement the new models in a manner that results in sustained improvements (e.g., establishing clear milestones and performance monitoring to ensure successful implementation and to prevent falling back into BAU practices).

A government initiative that catalyzes the adoption of improved PV business models has the potential to enhance other programs and policies and result in a significant change in the way PV business is done or even conceptualized. This can be crucial to help PV progress to a sustainable, zero-subsidy industry by reducing the initial cost and addressing other barriers to PV. In California, this approach complements the larger goal of the state government to accelerate PV adoption.

Part II of this document shows how the Energy Commission has begun to catalyze improved business models for PV applications in residential new construction, and more specifically for ZENHs. Part II also provides guidelines for additional steps the Energy Commission can take to sustain business model improvement and adoption, and achieve the goal of a subsidy-free industry.

2.0 PART II: Development of Improved Business Models for Sustained Market Growth

2.1 Introduction

As described in Part I, improved business models have the ability to change the way business is done and speed the adoption of a new product. Innovation of business models, as technology, is a process that requires iterative development; each iteration moves the business model closer to the intended goals. Critical to this iterative process is systematic analysis that allows for maximum learning of what works, what does not, what needs to be tested and what should be pursued.

In the case of the Energy Commission, the process of PV business model innovation has begun. The Energy Commission has successfully catalyzed the development of proposals from industry that included improved PV business models. (Section II.2) and the Energy Commission has selected several proposals of pilot projects for funding.

However, funding a few selected improved business models is not sufficient to significantly accelerate rates of business model change. Rapid development and use of improved business models will also require rigorous evaluation of the pilots to determine what works and what does not, and to transfer that learning to key stakeholders. This will allow the Energy Commission to determine how best to proceed and, ultimately, how to help industry reach a point where subsidies are no longer needed for accelerating PV market growth. (Section II.3)

2.2 Work and Results to Date

This section provides an overview of the work done to date in California to develop PV business models. Both the Energy Commission's catalytic activity and industry's response are addressed.

2.2.1 Energy Commission's Catalytic Activity

Known for its investments in technology improvements and market barrier reduction, the Energy Commission had not formally worked on stimulating development of improved business models prior to the Zero Energy New Homes (ZENH) solicitation, which was held in late 2005. The ZENH solicitation was developed by the Public Interest Energy Research Program (PIER) at the Energy Commission to push forward in California innovative and cost-effective combinations of building energy efficiency and PV strategies in new housing developments to reduce homeowner energy costs, energy use, and summer peak electricity demand. A major focus of the solicitation was to stimulate the creation of new partnerships involving multiple market participants to reduce the cost of PV-ZENHs to homeowners by encouraging new business models.

Through the solicitation the Energy Commission made funding available for the pilot projects. While the request for proposal (RFP) was not prescriptive with regard to specific business model approaches that teams should use, the Energy Commission was clear about the desired outcome. The ZENH RFP included a number of goals which reflect the market barriers the Energy Commission decided were most important to address. For example, the RFP stated that the improved business models needed to reduce the homeowner's first cost related to the PV system and the energy efficiency improvements to \$5,000, and reduce household energy use and demand. The RFP also required that proposals bring together teams to form new types of working relationships and partnerships. Respondents were left to develop the best pathways to achieve the cost and partnership requirements.

The Energy Commission provided a few opportunities prior to the release of the RFP which allowed potential respondents to discuss, explore and develop improved business models. A workshop was conducted and attended by over 100 PV-ZENH stakeholders, including representatives from the PV industry, new home construction, utilities, financial industry and local government. Workshop participants defined the value of PV as part of ZENHs for each group of stakeholders. Participants also discussed what they could contribute to new partnerships, and how these partnerships could overcome market barriers using improved business models. These activities helped stakeholders explore and build partnerships and develop improved business models. In addition, networks and contacts were established through this workshop and in subsequent working sessions.¹⁴

2.2.2 Industry's Response

The Energy Commission received nine proposals to the ZENH solicitation, reflecting solid participation from the major PV-ZENH stakeholder groups. Manufacturers, utilities, builders/developers, financial entities and cooperatives all had major roles in the proposals. Although this paper does not disclose the details of the proposals received, it does examine the proposed changes from BAU and the potential impact of these changes on the persistent market barriers. First, this section uses the three levers of innovation to categorize the proposed changes from BAU. Then the proposed business model changes are compared to the seven core business model concepts discussed earlier in the paper. Next, this section examines how well the proposed business models could address the persistent market barriers identified in Part I.

¹⁴ For a detailed description of the output from the CEC's workshop and working groups, see <http://www.energy.ca>.

[[We e-mailed the Energy Commission asking if they took this information off the web. At present we can not locate it.]]

Proposals Compared to Three Levers of Innovation

The three levers of innovation are a valuable tool to show a snapshot of how the proposing teams decided to move from BAU to improved PV business models for ZENHs. Using the framework of the three levers of innovation, Figure 4 categorizes the business model changes described in the ZENH proposals.

Value Proposition	Supply Chain	Target Customers
<i>What is sold and Delivered to the market</i>	<i>How the value is delivered to the market</i>	<i>To whom is the value delivered</i>
<ul style="list-style-type: none"> • Financing packages overcome first cost • Electric bills are reduced • Improved aesthetics and increased value to homeowner from BIPV products. • Reduced hassle for builder and homeowner from streamlined processes and third party participation in sales cycle. Increased value to builder through entitlements and permitting. 	<ul style="list-style-type: none"> • Product sold directly from manufacturer to builder (channel streamlined for cost savings). • PV-ZENH products bundled together with energy efficient products. 	<ul style="list-style-type: none"> • Target customer for residential PV systems moved beyond just the homeowner to include: <ul style="list-style-type: none"> - Builder/Developer - Utility - Third Party

Figure 4 The proposed new business models in the three levers for innovation

Proposals Compared to the Seven Core PV Business Models

The improved PV business models in the ZENH proposals incorporated many of the concepts identified earlier in this document as part of the seven core improved business models. In eight of the nine proposals, the PV business models combined two or more of the seven core improved business models to form the basis of their approach. NCI and the Energy Commission were correct in anticipating that teams would use more than one improved core business model to address market barriers and provide sufficient incentives for key stakeholders in order to ensure their participation.

In addition to the seven improved core business models, the proposals contained two new concepts:

- **Co-Op Ownership.** This model develops a cooperative of homeowners to finance, own and maintain a PV system. Both a centralized (one system per housing development) and a decentralized PV (per house) approach cooperative model were proposed.
- **Use Of Modular House.** This model incorporates PV into a specific existing product, a modular ecological home, which is currently targeted at an environmentally conscious homebuyer. This business model takes the “PV is the Roof” business model one step further by selling the pre-fabricated home with an integrated PV system.

How Well Proposals Address Market Challenges

As a group, the business models that the Energy Commission received as part of the ZENH proposals addressed significant market challenges described in Part I, Section 1.2.2. Similar to the improved core business models described earlier in the document and as depicted in Figure 3, the proposed business models do a good job of addressing two of the major market challenges; high initial system cost and limited customer value. How the proposals address these two specific market challenges is described in the table below.

Table 2: How Improved Business Models Address Market Challenges

Market Challenges	How Proposals Addressed
High initial system cost	To reduce the initial cost to homeowners, many proposals used financial mechanisms such as rolling the cost of the PV system into the home mortgage and partnering with groups that could bring in commercial finance. (Similar to: <i>PV Enhanced Mortgage, PV Consumer Finance</i>) In addition, but to a lesser degree, some proposals found ways to reduce the cost of the PV system by streamlining the product delivery channel to the homeowner or builder. (Similar to: <i>PV As an Appliance</i>)
Limited value to homeowner	To increase value to homeowners, many proposals included a new BIPV product instead of roof mounted PV modules to improve aesthetics, avoid roofing costs and (potentially) increase roof insulation. (Similar to: <i>True Value Electric Roof</i>) In addition, some proposals recognized the importance of reducing homeowner hassle related to PV system installation an on-going maintenance. (Similar to: <i>“No Hassle” PV, PV Enhanced Affordable Multi-family</i>)

The proposed business models also dealt with other market challenges such as limited value for the builder and utility. In a number of the proposals, teams mentioned the importance of using entitlements to increase the value of PV systems to the builder; however, only one team provided detailed information on how builder entitlements might be developed with a specific city. Increased utility value was demonstrated by one utility considering ownership options for distributed residential PV.

2.2.3 New Business Model to be Piloted

Of the nine proposals received, the Energy Commission decided to fund three. The selection was based on criteria not exclusively concerned with improved business models, as the RFP also had broader goals regarding achievements in higher energy efficiency in new home construction, lower peak demand and reductions in electricity bills, etc. The entire list of selection criteria is available from the Energy Commission.

The three improved business models that will be piloted are described below. The most significant changes to the BAU business model are found in the financing structure (to address initial cost) and in the products used (to address aesthetics and value to homeowner).

- **Affordable Multi-family Housing:** The Affordable Multi-Family Housing proposal utilizes roof-top and common space PV systems on an affordable multi-family housing project. The PV system will be owned and financed through a third party for the first fifteen years of the project, thereby completely eliminating any additional upfront cost to the tenants and the building owner/developer.
 - The major component of change from the BAU business model is the use of third-party finance and ownership.
 - The main stakeholders involved are an affordable housing developer (Global Green), a company that will finance and own the PV system (SunEdison) and a PV installer (Altair Energy).
- **Utility Focused:** During the course of the pilot, the Utility Focused proposal will determine which of three ownership options (or combination of options) for a PV system is best for the utility. The ownership options include: 1) Customer owns the PV system and utility provides financial incentives, 2) Utility owns the PV system and customer leases it, or 3) Utility owns the PV system and pays customer rent for roof space. The proposal includes the use of a new BIPV product. The team also proposes that it will develop builder entitlements at the municipal level to increase the value of the PV systems for builders.
 - The major changes from the BAU business model are utility ownership of a PV system (although this is not a totally new approach as utility companies such as Sacramento Municipal Utility District have owned PV before, it is a departure from the more common customer ownership model), the use of BIPV, and the (potential) development of builder entitlements.
 - A main stakeholder involved is the utility (Southern California Edison) who will collaborate with a PV manufacturer (Sharp Solar). Theoretically, if SCE develops a program that is large in scale, volume pricing would reduce the cost of the PV systems.
- **PowerLight Homes:** In the PowerLight Homes proposal a new BIPV product that is aesthetically attractive, maintenance-free and provides roof insulation is incorporated into a turn-key solution and sold to single- and multi-family homeowners. The upfront cost of the system may be financed through Fannie Mae (for multi-family) or a third party (for single-family). The product delivery channel is streamlined between manufacturer and the builder. Builder entitlements will be developed along with streamlining city permits to entice builders to use PV.
 - The major components of change from the BAU business model are a new BIPV product, financing, delivery channel streamlining (system

cost reduction and lower hassle for builder), builder entitlements and the development of easier city permitting.

- The main stakeholders involved are a PV manufacturer and installer (PowerLight), a financial institution (Fannie Mae), and a city (City of Brentwood).

2.2.4 Is the Approach Working?

The implementation of the improved PV-ZENH business models is just beginning so the results of this approach are not yet available. However, the Energy Commission has taken an important first step in catalyzing change in the BAU approach to growing the PV market.

As stated above, the process of improved business model development and adoption is iterative. The first round of proposed improved business models is expected to provide information that can be used to make further improvements. In this first round of pilots, the level of detail provided in the proposals on new business models elements and pilot implementation varied significantly and, in some cases, very little information was provided. For example, financial instruments for addressing first cost were not clearly identified in several proposals. In some cases, partnerships were not fully formed or were missing a major stakeholder required to make the business models work. This level of detail (and omission) is consistent with the first steps in business model change and is expected before pilot testing. However, it is also expected that these details will be defined (and refined) as part of the Energy Commission's pilot activity.

As a group, the improved business models described in the proposals reflect trends and behaviors seen in other industries that have undergone change as a result of improved business models. For example:

- No single dominant improved business model emerged immediately. Industry is pursuing multiple possible pathways for accelerating PV adoption, and further refinement will occur with time and experience.
- The overall attractiveness of an improved business model varies by stakeholder; the attractiveness of a business model depends on the perspective of a particular stakeholder.
- Many new partnerships were formed (e.g. city officials working with PV manufacturers).
- The improved business models incorporate new elements with old elements from the BAU business model.
- While there was no lack of creativity, many proposals pursued similar approaches to improving business models.

- Some market barriers were addressed in multiple proposals and with credible approaches (e.g., high up-front cost and aesthetics of PV), while other market barriers were either not addressed at all or addressed in a manner that did not appear entirely well thought through.
- Business models that are more complex and require more innovation are harder to implement; they may take more time to develop, and are more risky. However, in the long-run these business models might have the largest impact on the marketplace. The business model improvements in the Energy Commission pilots appear to be focused on less risky approaches and provide a good test bed for the improved business models.
- Niche markets, like modular homes and affordable housing, may be easier to develop in the short-term because the market has relatively few participants who would be easy to contact. In addition, the key decision makers (customers of modular homes, or low-income housing developers) may have a pre-disposition to want solar PV. However, the market size for the niche markets is smaller than for single-family homes.

Ultimately, the success of the Energy Commission’s pilots of improved business models will depend on refinement, modification and rigorous testing. It is critical that the Energy Commission monitors and guides the pilots to ensure development of robust and complete business models that are well connected to the marketplace, the consumer and technological advances.

2.3 What Needs to Come Next

2.3.1 A Framework for Continuing Business Model Innovation

While the Energy Commission’s next step is to pilot three of the proposed business models, these pilots are part of a larger effort. The end goal is not simply to pilot a few new ideas, but rather, to accelerate PV penetration and ultimately reduce subsidies to zero. This may require examination of the pilot results and analysis of other PV business models to gather as many good ideas and options as possible into the development process. By understanding the keys to success for improved business models, the Energy Commission can determine how to approach the next iteration of business model innovation.

This section outlines the major next steps for the Energy Commission to continue catalyzing business models that can operate with reduced and, eventually, zero subsidy. Figure 5 provides an overview of the recommended next steps. This process is described in the sections below.

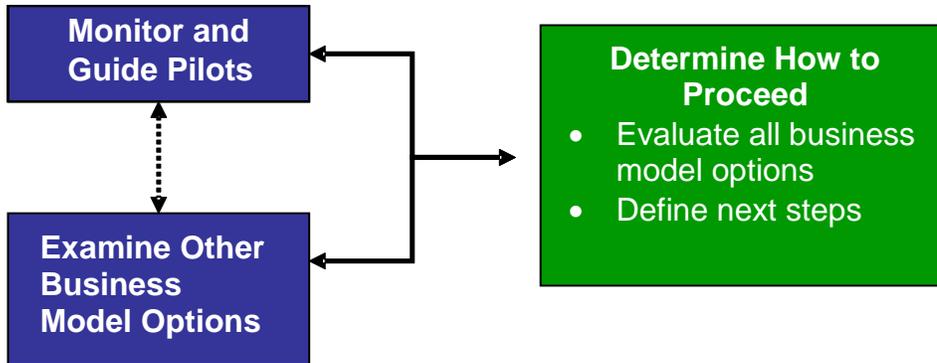


Figure 5: Recommended process for continuing development of improved business models

2.3.2 Monitor and Guide Pilots of Improved Business Models

Some aspects of the pilot business models have not been tested before; others have been implemented previously, but not rigorously monitored and evaluated. During the pilot process it will be critical to monitor the pilot activity in a rigorous way to identify and characterize the key factors of success. A reporting process is already in place for the three teams piloting new PV business models. This may or may not capture all the information relevant to understanding the key factors to success. This section provides ideas on what would need to be monitored to capture the key factors of success and challenges related to implementing new PV business models.

The Energy Commission’s interaction with the teams should not be limited to monitoring progress against project milestones. The Energy Commission needs to work hand-in-hand with pilot teams to capture the tremendous amount of learning available during implementation. The Energy Commission can add value in helping the teams stay the course. For example, there may be a temptation for pilot teams to fall back on BAU practices when it becomes hard to implement new aspects of the business models. The Energy Commission can add value by helping teams push past hurdles in implementing the improved business models.

Documenting the business models that are actually implemented (which might differ from what was proposed) is an important first step in the monitoring process. It will be important to understand, for example, the variation between what was proposed and what is actually implemented. It is essential to determine why there was any difference between the proposed and implemented business models.

The Energy Commission is already planning to collect some data that will be helpful in understanding the performance of the improved business models, for example; the price of installed systems, initial cost for the homeowner, frequency of use of financing mechanisms, and the monthly cost of electricity.

However, to understand why a business model is working (or not), it will be important to go beyond the simple metrics listed above. The types of business model qualities that need to be evaluated are listed below and can be quantified through interviews with pilot teams, their customers and other stakeholders.

- **Partnerships:** Are the partnerships sustainable? Does the partnership provide mutual benefits?
- **Supply Chain:** Is the product delivery efficient and effective?
- **Value:** Is there a consistent and clear articulation of the value proposition to stakeholders? Is there a clear reason for them to purchase the PV system?
- **Do-ability:** Was the proposed business model able to be implemented as planned? Were there significant, unexpected barriers? Can the business model be replicated?

Part of the important learning to be derived from these pilots is how government, specifically the Energy Commission, can be an effective catalyst of improved business models. A few examples of questions that should be addressed include:

- Was the Energy Commission able to add value to the pilot programs?
- Was the Energy Commission involved with each pilot program closely enough to provide timely and constructive feedback or was the Energy Commission too closely involved, and actually hindered the performance of the pilot?
- Was the feedback provided by the Energy Commission to the pilot teams useful?
- Was the Energy Commission able to aid in the resolution of any regulatory, governmental or other hurdles faced by the pilots?
- What else could the Energy Commission have done to further the success of the piloted business models?

Interviews with pilot participants and the Energy Commission staff to address the questions above will provide key insights regarding the best role for a government agency in catalyzing business model improvement.

2.3.3 Determine How to Proceed

This paper has emphasized that the process of developing improved business models is iterative. After implementing the pilots and gathering information on other business models the Energy Commission will have a tremendous amount of valuable information on which to base its next steps. The Energy Commission will also have evaluated its own performance and have developed a better sense of the most effective ways it, as a government agency, can act as a catalytic force.

Evaluating and comparing all of the business models, those piloted and those researched, will require an approach capable of taking into account the large variations of improved business models. A systematic, rigorous and consistent process for comparing different business models is needed. NCI developed such a process with the Energy Commission called the Business Model Evaluation Tool (BMET). It evaluates the value and do-ability (the inverse of risk) of all the business models and allows for comparison between them. (For a more detailed description of the BMET please see Appendix C). Using the inputs from the pilot activity and any additional research on PV business models, the BMET can be modified to help the Energy Commission define the key elements to success in improved PV business models for new home construction.

Once the Energy Commission has gathered and analyzed all the information regarding additional business models then decisions can be made as to the most appropriate next steps with respect to catalyzing the development of improved PV business models.

3.0 Conclusions

The Energy Commission's work to catalyze improved PV business models in the California marketplace has shown that business model innovation may be an effective approach for addressing major PV market challenges. Business model innovation can complement technological innovation already occurring in the industry, and as a policy approach can strengthen work the Energy Commission is currently funding to promote PV adoption more broadly in the state. The work to date by the Energy Commission on improved business models constitutes an important first step. However, in order to keep the catalytic process moving forward the Energy Commission will need to monitor and guide pilots. While the improved business models approach can be used more broadly by the Energy Commission to foster growth of other PV market segments, it is an approach that can also be adopted by other organizations, including other government agencies.

APPENDICES

Appendix A: Estimated Price of Installed PV Systems with Improved Business Models

Appendix B: Description of the Seven Core Improved Business Models

Appendix C: Description of Business Model Evaluation Tool

Appendix A: Estimated Price of Installed PV Systems with Improved Business Models

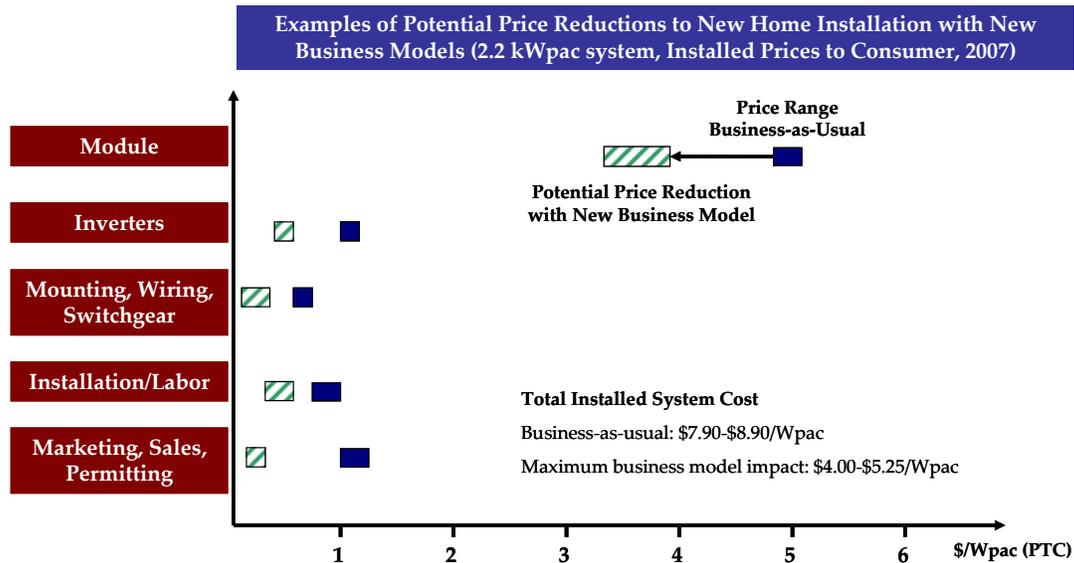
NCI spoke with industry in September 2004 and used previous research to forecast the price of a PV system in 2007. NCI took into consideration both advances in technology and manufacturing that would lead to lower cost as well as the impact improved business models would have on cost.

The analysis was done for a 2.2 kWpac PV system installed in a Californian single-family production home. The analysis assumed that multiple systems would be installed at the same time, thus providing some economies of scale and resulting in 2004 average system prices slightly below the California average of \$9.33/Wpac.

The potential reduction in system price is shown below in Figure A-1. The current price is shown with a solid box and the lowest expected price is shown with a stripped box. Both the current and future prices are shown with a range to reflect uncertainty. There was a difference of opinion in industry as to how to break-down and categorize price. Different players in the supply channel tend to break-down price and treat costs differently. By the end of the research there was consensus among industry members on the total system prices while there was still some discrepancy on how to most accurately treat the price break-down. The points below summarize the findings:

- 2004 price average for a 2.2kWpac retro-fit system: \$7.90 - \$8.90/Wpac
- 2007 price for a 2.2kWpac production home system: \$4.15 - \$5.40/Wpac
- 2007 price for a 2.2kWpac production home system using building integrated PV: \$4.00 - \$5.25/Wpac

Figure A-1: An Example of Maximum Price Reduction for a PV System



Source: NCI estimates based on PV industry interviews September 2004.

The significance of Figure A-2 is that it shows relatively how much cost reduction is possible for each price category. The largest areas for cost reduction are the PV module and then marketing, sales and permitting. What this indicates is that reducing the cost of PV modules from the manufacturing plant is just as important as creating greater efficiencies in marketing, sales and permitting. It is important to note that the cost categories shown above include the appropriate supply chain margins on each component. Therefore, all of the reductions in the PV module do not come from simple reductions in the price manufactures offer, but also improved efficiencies in the supply chain.

This analysis demonstrates that while price reductions in PV systems are driven by the falling costs of PV modules, it is equally important to look at how business models can be developed to reduce costs in other areas.

While this price analysis was useful to NCI and the Energy Commission, it is important to remember that although high initial system price is an issue with stakeholders, there are other barriers that hold back market potential. An improved business models approach takes a holistic look at how to create value for key stakeholders; this includes, but is not limited to, reducing the system price. For example, the improved business model approach advocates for understanding all the market barriers and creating value for key stakeholders to increase their purchase motivation.

A final aspect of price to keep in mind is that while it is important to work on reducing the market price, the initial cost to the homeowner can also be addressed using financing instruments. Developing widely available and easily useable financing mechanisms may prove to be just as important as reducing the system price.

This information was used to help the Energy Commission evaluate how well the new business models addressed the barrier of high initial cost. The tool developed and used to evaluate business models is found in Appendix C.

A more detailed explanation of the cost reduction for each category is shown below in Figure A-2.

Figure A-2: An Example Estimate of Reductions in Installed PV System Cost

Examples of PV Installed Costs (\$/Wpac PTC) for 2.2 kWac System			
	Typical Installation*	Business Model Impact by 2007	Reason for Reduction
Module	4.50 – 4.80	3.00 – 3.60	<ul style="list-style-type: none"> • Manufacturing learning curve and technology improvements • Gross margin reduction from 25% to 10%
Inverters	1.00 – 1.20	.40 - .70	<ul style="list-style-type: none"> • Volume production of smaller inverters • Gross margin reduction from 25% to 10%
Mounting/Wiring /Switchgear	.60 - .70	.25 - .35 rooftop .10 - .20 integral	<ul style="list-style-type: none"> • Volume production of components • Gross margin reduction from 25% to 15% • Additional savings are gained from material credits of \$2/sq. ft. for roof material not used e.g. tiles or sheathing (integral)
Installation/Labor	.80 – 1.00	.35 - .55	<ul style="list-style-type: none"> • Learning curve acceleration from higher volume of installations with a contractor and clustering of installations • Homes pre-configured for PV (e.g. reduces installation to 2.5 – 3 hours)
Marketing/Sales/ Permitting	1.00 – 1.20	.15 - .20	<ul style="list-style-type: none"> • Increased education and training of building code officials and inspectors • Increased education of builders and consumer • Faster learning curve impacts
TOTAL	7.90 – 8.90	4.15 – 5.40 4.00 – 5.25	<ul style="list-style-type: none"> • Manufacturing volume • Manufacturing learning curve • Gross margin reduction from 25% to 10%

Source: NCI estimates based on discussion with PV industry. Low end of range on estimated business model impacts assumes volume installations of systems on new construction.

*Retrofit installations in California.

Appendix B: Description of the Seven Core Improved Business Models

Business Model #1: PV as an Appliance

Description: The *PV as an Appliance* business model centers on the notion that a PV system can be sold to a homeowner or builder and incorporated into a home just like an appliance. The PV system is a standard, pre-engineered product that comes with full performance guarantees and warranties, again just as would a standard appliance. The product is sold through high volume sales channels and could include options for financing and maintenance contracts.

Primary Characteristics

- The **manufacturer** develops a standardized residential PV package and sells it through high volume sales channels (large builders, big-box-stores, household appliance distributors).
- The **builder** is able to treat the PV system like any other appliance in the home (e.g. a furnace), and includes it as a standard feature making a margin on its sale. Similar to a furnace, the builder shares the responsibility for liability with the manufacturer.
- The **homeowner** views the PV system as one more appliance in their home relative to its purchase, service, maintenance and financing.

Optional Features

- The **utility** could drive demand for these standardized PV packages by offering incentives, similar to current programs which promote the use of energy efficient products (e.g. rebates for appliances with the EnergyStar® label).
- The **manufacturer** could offer new PV products designed to appeal to consumer preferences, including consumer financing, maintenance contracts, or changing the color, shape, or style of the products.

Market Barriers Addressed

- **Initial system cost is high:** PV system costs are reduced through economies of scale due to standardization, and streamlined product delivery.
- **Value to the homeowner is limited:** The value to the homeowner is increased by significantly reducing the hassle associated with selecting and purchasing a PV system. The fact that the system includes a performance guarantee also decreases the financial risk to the consumer, thereby increasing the overall value.
- **Additional hassle and risk for builder:** Due to the PV package performance guarantees and the warranties, risk to the builder is reduced. Installation is also simplified through system standardization.

Business Model #2: No Hassle PV

Description: The *No Hassle PV* business model centers around the idea of a single entity (a company) that bundles the PV system design, purchase, permitting, rebate application, installation, maintenance and possibly financing into one single, simple transaction for the customer (homeowner or builder).

Primary Characteristics:

- A **single entity** (an existing market participant or a new third party) assumes multiple roles in the PV transaction (e.g., one stop shopping), thereby significantly simplifying the transaction for the customer (homeowner or builder).
- This **single entity** can attain both transaction and installation cost reductions by streamlining and aggregating processes (design, installation, permitting, incentives, lending) and these savings can be passed onto the customer.

Optional Features:

- The **PV manufacturer** could offer volume pricing to this single entity, further reducing costs.
- The **single entity** could have access to benefits that are difficult for a single customer to obtain. For example, accessing and monetizing Renewable Energy Credits would be more cost-effective on an aggregated basis.
- A **lender** could offer preferential lending rates through the single entity for standardized and/or volume transactions.
- The **single entity** could also own the PV system and sell the electrical output to customer. This could eliminate upfront capital cost to customer as well as remove all long-term performance and operating risks.

Market Barriers Addressed:

- **Initial system cost is high:** PV system costs would decrease through volume pricing as well as streamlined and aggregated processes (e.g. design, installation, permitting, incentives, lending)
- **Value to homeowner is limited:** Value to the homeowner is increase as the hassle associated with purchasing, owning and maintaining a PV system is completely removed.
- **Additional hassle and risk for builder:** The introduction of a separate entity that is responsible for all aspects of the PV purchase and maintenance helps to reduce the hassle and risk for the builder.

Business Model #3: True-Value Electric Roof

Description: With the *True-Value Electric Roof* business model the PV system becomes the roof, replacing a portion of the roofing materials used in new home construction. This building integrated product could be used in both single- and multi-family residences. Time-of-use electricity metering provides the homeowner with improved economic incentives and helps to decrease monthly electric costs.

Primary Characteristics:

- The **builder** offers roofs that are completely, or at least substantially, PV as an option to homeowners.
- The **utility** allows time-of-use metering which improves PV system economics for the homeowner, thereby encouraging their inclusion in new homes.
- The **manufacturer** develops product(s) suitable to replace entire (or a large portion of) roof.
- **Financial institutions** include the price of the PV system in the home mortgage.

Optional Features:

- The **PV manufacturers** could develop PV roofing options that are customized to increase aesthetic appeal.
- **Roofing companies** could sell and install PV roofs.

Market Barriers Addressed:

- **Initial system cost is high:** The PV system replaces all (or a large portion) of the roof, thereby offsetting material costs for the roof. As a result, the overall cost of the roof plus PV is reduced.
- **Reduction in monthly electric cost is not noticeable:** Monthly electric costs are noticeably reduced as a result of time-of-use metering. There is also an improved pay-back period due to these rates.
- **No added value for builders:** Builders are able to sell a differentiated product to homeowners, thereby increasing their competitive advantage in the marketplace.

Business Model # 4: PV Enhanced Multi-Family Buildings

Description: The *PV Enhanced Multi-Family Buildings* business model utilizes a large PV system that is included as part of new construction in order to reduce the on-going electric bills. The PV system may be located on-site or elsewhere if roof-space is limited.

Primary Characteristics:

- The **developer** of multi-family building includes the cost of the PV system in the total cost of the project, and designs the PV system to cover a portion of on-going electricity demand¹⁵. This model is attractive for affordable housing developers as initial capital maybe easier to access than funding for on-going operational costs.
- **An affordable housing developer** maybe able to access additional tax credits¹⁶ by including a PV system in the development. This could make the investment in PV even more attractive.

Market Barriers Addressed:

- **Initial system cost is high:** The per watt cost of the PV system is reduced due to its larger size. The apparent cost of the system may be lower if the affordable housing developer is able to acquire additional tax credits due to the including the PV system. Initial cost of the PV system to the tenant is reduced entirely since the building owner owns the PV.
- **Reduction in monthly electricity cost in not noticeable:** The on-going operating cost of the building is reduced, and monthly savings can be passed on to the tenants.
- **Additional hassle and risk for builder:** The hassle and risks for the builder is reduced due to the single, large installation.

¹⁵ Even if tenants pay their own electric bills, the building owners may still pay for electricity in common areas (hallways lighting, outdoor lighting, etc.). The PV electricity could be used in common areas, or be sized to meet a portion of the tenant's demand. In situations where the building owner pays for electricity and includes it as part of the rent, savings in monthly electric costs could be passed onto tenants.

¹⁶ Affordable housing developers rely on tax credits allocated to them from the government which they then sell in order to finance projects.

Business Model #5: PV Consumer Finance

Description: In the *PV Consumer Finance* business model, the initial PV system cost is financed¹⁷ using standard consumer finance channels. The financing could be provided to the consumer by a PV manufacturer, other market participant (e.g., distributor), a new 3rd party, or an independent financing entity.

Primary Characteristics:

- A **consumer finance** entity provides standardized financial products for PV systems at rates and terms consistent with the consumer financing market.
- The **homeowner** needs only to fill-out a standard consumer finance application for the loan qualification process.
- By leveraging existing **consumer finance channels**, the consumer finance entity reduces its cost of operations and has the infrastructure in-place to support high volume sales.

Optional Features:

- The **PV manufacturer** could vertically integrate, becoming the consumer finance entity. By bundling PV system equipment and finance together for customers, the manufacturer could gain added revenue.
- The **consumer finance entity** could also offer performance guarantees and other risk mitigation products (e.g., homeowner PV insurance).

Market Barriers Addressed:

- **Initial system cost is high:** The upfront cost of the PV system is significantly reduced or eliminated for homeowner.
- **Value to homeowner is limited:** There is no added hassle for the customer to finance the PV system since *PV Consumer Finance* is similar to other finance options currently in existence.

¹⁷ Capital or operating lease.

Business Model #6: PV Enhanced Mortgage

Description: Using the *PV Enhanced Mortgage* business model, lenders incorporate the PV system cost into the home mortgage and provide “enhancements” to the mortgage terms because the new home has PV installed.

Primary Characteristics:

- **Lenders** include the PV system cost in the total mortgage amount, but also include future electric bill savings and the sale of Renewable Energy Credits (RECs) to supplement the homeowner’s income in the computation of approved maximum mortgage amount. As a result, the homeowner qualifies for a higher mortgage because of the additional income; the lender is able to lend more money, but has to assume no additional risk.

Optional Features:

- **Financial institutions and investment brokers** package PV-home mortgages into large bundles (e.g., \$10-\$50M +) for sale to institutional investors (large banks, pension funds, socially conscious investment consortia). These investors are willing to pay more for the unique financial characteristics of the “PV” mortgages. The financial institution could receive a premium for the bundled mortgages which could be passed back to the homeowner in the form of a slightly discounted lending rate.

Market Barriers Addressed:

- **Initial system cost is high:** The upfront cost of the PV system is significantly reduced or eliminated for homeowner.
- **Value to the homeowner is limited:** The homeowner’s total authorized mortgage amount is increased by the lender due to the income (reduced electric cost) generated by the PV system. Since the PV system is incorporated into the home mortgage, there is no additional hassle for the homeowner.

Business Model #7: Utility PV in Subdivision

Description: With the *Utility PV in Subdivision* business model, a utility develops and owns PV assets in new subdivisions either on a house-per-house basis or as a small centralized system located within or near the subdivision.

Primary Characteristics:

- The **utility** provides for the new electricity demand within the subdivision in a manner that is cost effective. The utility is able to avoid developing additional generation, transmission and distribution assets on the existing grid through the use of the PV system.
- The **homeowners** are charged monthly bill by the utility for electricity service (a combination of the PV system and the grid). From a customer's perspective nothing changes, except that there is PV on their roof or in their subdivision.
- As a result of the PV system(s), the **builders** do not need to worry about the potentially high cost of grid interconnect for the subdivision due to the additional demand on the grid¹⁸.

Optional Features:

- The **utility** could also provide incentives to builders and homeowners to use energy efficient appliances, thereby further reducing the demand for electricity in that subdivision¹⁹.

Market Barriers Addressed:

- **Initial system cost is high:** The upfront cost of the PV system is eliminated for homeowner.
- **No added value for builder:** The builder / developer's cost of grid interconnect is potentially reduced.
- **Value to the utility is limited:** The utility's cost of providing service is reduced. Utility can take the Renewable Energy Credits from the PV system and use the PV system toward meeting their targets for Renewable Portfolio Standards.

¹⁸ For a builder, the cost of the interconnect can be substantial, especially when the additional electricity demands of a new subdivision will require that the utility modify the grid to cover the additional demand.

¹⁹ One water utility in Southern California is already working with builders to reduce water demand since the cost of water delivery is higher than water efficiency improvements.

Appendix C: Description of Business Model Evaluation Tool

Introduction

NCI worked with the Energy Commission to develop the Business Model Evaluation Tool (BMET) to evaluate and compare business models. The BMET is capable of taking into account a large number of variables in a consistent, rigorous and thorough manner. This allows users to evaluate and compare business models that vary widely.

The BMET was designed so that it could be tailored to the specific needs of key stakeholders. Since different stakeholders view the impact of improved business models differently, it was critical to allow the user to have the ability to modify the BMET to best reflect their perspective.

The BMET tool has two main components, the evaluation of “Value” and the evaluation of “Do-ability”. Value is defined as how well the improved business model addresses specific market barriers. The business model generates value for stakeholders as it addresses the persistent market barriers. Do-ability is defined as how easy (or hard) it is to implement the improved business model. Do-ability can also be thought of as the inverse of risk.

Value

“Value” in the BMET is defined as how well an improved business model overcomes market barriers. Therefore the key barriers are listed and then the business model is evaluated on a score of one to five based on how well it overcomes each one. In this scoring one represents business-as-usual and five indicates that the improved business model totally eliminated the barrier. In Part I Section 2b there are four categories of barriers described; economic, value to the homeowner, value to the builder, and value to the utility. For purposes of evaluating improved business models for the Energy Commission these four categories of barriers were expanded to provide more precision for areas of particular interest to the Energy Commission. As mentioned above, tailoring the BMET to a user’s needs is a critical component to the evaluation.

The specific components of Value the Energy Commission used to evaluate improved business models were:

- Initial system cost is high. The high up-front cost of the PV system inhibits potential sales. The installed system cost of a business model was calculated and ranked on a 1 to 5 scale where 1 represents an installed system cost of $\$8 / W_{pac}$ (or more) and a 5 represents $\$4 / W_{pac}$ (or less).
- Reduction in monthly electric cost is not noticeable. The purchase of a PV system may not appreciably decrease monthly electricity costs, especially if monthly payments are made to a PV system. The reduction in monthly electric costs for each business model were calculated and ranked on a 1 to 5 scale where 1 represents no reduction in monthly electric costs and 5 represents a 70 percent (or more) reduction in monthly electric costs.
- No added value for builder. By adding PV to a new home, there is no added value for builder. Ranked on a 1 to 5 scale where 1 represents no additional value for builders and 5 represents a situation where the builder perceives tremendously more value (through extensive entitlements, for example).

- Additional hassle and risk for builder. Adding PV is difficult for builders: a hassle. In addition, builders worry about their long-term liability associated with the PV system. Ranked on a 1 to 5 scale where 1 represents no reduction in the hassles and risks and 5 represents a complete elimination of the barrier.
- Value to homeowner is limited. Electric savings alone do not motivate a homeowner to purchase a PV system. Homeowners perceive “hassle” related to purchase and maintenance, and do not “value” the PV image, potential savings on roofing materials, and increased electricity reliability. Ranked on a 1 to 5 scale where 1 represents business as usual and 5 represents the situation where the value to the homeowner is increased tremendously.
- Value to utility is limited (unwilling to cooperate). Utilities see little value in residential PV and do not facilitate its up-take in the marketplace. Ranked on a 1 to 5 scale where 1 represents business as usual and 5 represents the situation where the value to the utility is increased tremendously.

In calculating the “Value” score, the barriers were not weighted evenly, but were weighted according to their importance as defined by the Energy Commission. High initial cost was identified as by far the most significant barrier limiting PV adoption, and so was the most heavily weighted. Value to builder along with hassle and risk for builder and reduction in monthly electric costs were seen as the next most significant barriers, followed by value to homeowner and utility. Specific weightings are shown in the figure below.

Figure C-1: Value Score Criteria and Weighting

Value Score Criteria		
Cost		Weighting
Initial System Cost is high	The high up-front cost of the PV system inhibits potential sales.	55%
Reduction in monthly electricity costs is not noticeable	Purchase of a PV system may not appreciably decrease monthly electricity costs, especially if monthly payments are made on PV system.	10%
Other Barriers		Weighting
No added value for builder	By adding PV to a new home, there is no added value for builder. An example of the builder was given “entitlements” from gov’t allowing quicker time to market.	15%
Additional hassle and risk for builder	Adding PV is difficult for builders: a hassle. In addition, builders worry about their long-term liability associated with the PV system.	10%
Value to homeowner is limited.	Electric savings alone do not motivate. Homeowner perceives “hassle” related to purchase/maintenance, does not “value” PV image, savings on roofing, increased reliability.	5%
Value to utility is limited (unwilling to cooperate)	Utilities see little value in residential PV and do not facilitate its up-take in the marketplace. (Make interconnect difficult, etc.)	5%

Do-Ability

Do-Ability represents how easy (or hard) it is to implement a given business model (the inverse of risk). It was evaluated in a similar manner to Value, although the scoring worked slightly differently. Using a scale of one to five, one indicates that for that component of Do-ability the business model is almost impossible to implement. An example of a score of one is the need to develop cold fusion in order for the business model to work. A score of five indicates that that with regard to that component of Do-Ability the business models could be implemented today. An example of a score of five is the use of off-the-shelf PV modules.

NCI defined Do-Ability according to four components:

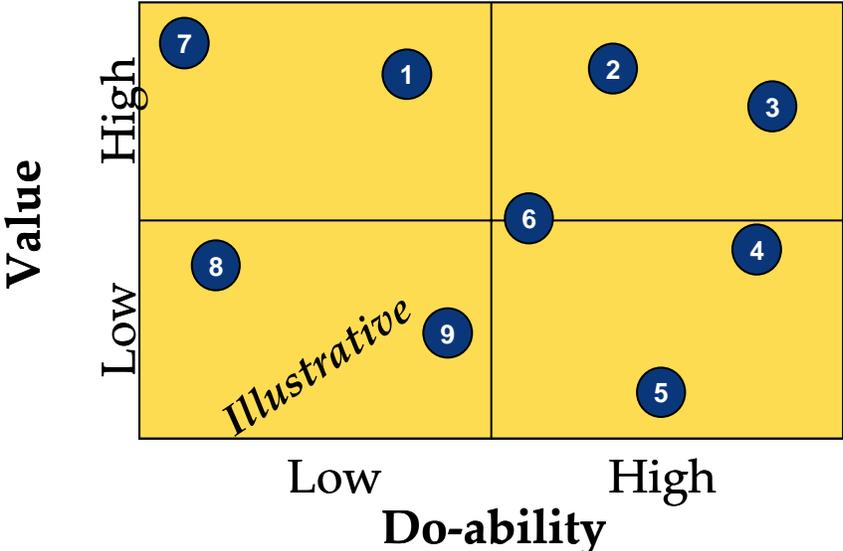
- **Economic.** Considers all capital required to successfully implement the business model. Ranked on a score of 1 to 5 with 1 meaning an insurmountable amount of capital is required, and 5 meaning all required capital is available.
- **Technical.** Considers all equipment, techniques and system integration issues required to successfully implement the business model. Ranked on a 1 to 5 scale with 1 meaning the technical requirements are not plausible in the near term (i.e. cold fusion) and 5 meaning the technology is currently widely in use.
- **Regulatory.** Considers all local, state and federal regulations pertinent to successfully implementing the business model. Ranked on a 1 to 5 scale with 1 meaning an insurmountable amount of regulatory changes is required, and 5 meaning no new regulatory changes need to take place.
- **Infrastructure.** Considers the supply chains and partnerships that must be in place in order to successfully implement the business model (e.g. equipment, services, financial, etc.) Ranked on a 1 to 5 scale with 1 meaning elements are not plausible in the near term, and 5 meaning all elements are currently in existence and proven.

Unlike the components of Value, the components of Do-Ability were all weighted evenly.

Comparison

After evaluating Value and Do-ability, each business model can be plotted on a two-by-two matrix. This allows for comparison of their relative Value and Do-Ability. The figure below illustrates a sample output from the BMET.

Figure C-2: Sample Output from the Business Model Evaluation Tool



In addition to the relative numeric ranking of Value and Do-Ability, the BMET also provides a general profile (qualitative comparison) for each business model. As a result of the rigorous process by which each business model is evaluated, the user gains key insights which can be recorded in addition to the numeric output.